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A Comparison of the Scientific Background of Ninth Grade Students who have Received their First Eight Years of Schooling in Rural Schools with those Educated in the Brookings City Schools

Floyd A. Johnson

A COMPARISON OF THE SCIENTIFIC BACKGROUND OF NINTH GRADE STUDENTS WHO HAVE RECEIVED THEIR FIRST EIGHT YEARS OF SCHOOLING IN RURAL SCHOOLS WITH THOSE EDUCATED IN THE BROOKINGS CITY SCHOOLS

A Problem

Presented to

the Faculty of the South Dakota State College

of Agriculture and Mechanic Arts

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

(Plan B)

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by

Floyd A. Johnson

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Floyd A. Johnson

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SECTION I

INTRODUCTION

The Problem

At the beginning of each school year in Brookings high school, Brookings, South Dakota, the investigator has noted that there seems to be a difference in opinion among instructors as to what is to be expected in mental ability and background of the incoming group of students comprising the freshman class.

Teachers often discuss among themselves how much or how little ability and educational background a student reveals during the first few days in a new class. There seems to be a tendency for teachers to take for granted two things: (1) that the student does not have adequate background in his particular course of study, which necessitates a review of fundamentals, (2) that the student does have adequate background, in which case no review of fundamentals is necessary.

E. F. Lindquist,[1] Director of the Iowa Every-Pupil Testing Program, states, "One of the most common and most serious mistakes made by high school teachers is that of

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[1] E. F. Lindquist, Interpretation and Use of the Test Results by the Classroom Teacher, (State University of Iowa, College of Education, Iowa City, Iowa, 1943), p. 13.

taking too much for granted concerning the abilities and previous knowledge of their students." He further states that there are some teachers of mathematics who assume that their pupils have mastered the arithmetical skills taught in the grades. Also, that some teachers in English assume mastery of punctuation and capitalization. The investigator believes that there are some teachers in science who assume that their students have established scientific attitudes; they assume that their students have learned to identify certain laboratory equipment, such as test tubes, flasks, and Bunsen burners.

As a teacher of general science in the ninth grade, the investigator has noted that with each new group of students registering for general science in Brookings high school, there are some students who do not have any conception as to the size and appearance of some of the simpler types of laboratory apparatus, such as test tubes, flasks, Bunsen burners, and cruicibles. Many simple experiments have to be performed over again for the benefit of those who have not seen similar experiments.

That there is great heterogeneity among the students who attend Brookings high school is substantiated through: (1) classroom recitation, (2) questioning, (3) personal observation, (4) investigation of each individual's personal

record card which is maintained for the purpose of counseling and guidance.

Purpose of the Study

The purpose of this study is to compare the students who have received their eight years of education in a rural school with those who have received their schooling in Brookings city schools to see if there is any significant difference between the groups as to their background in natural science.

SECTION II

PROCEDURE

Selecting the Groups

The two groups used in this study may be referred to as rural educated and city educated. From now on, in this study, the groups will be referred to as city and rural.

The city group of students attended Brookings city schools during the first six years of elementary school and two years of junior high school. By referring to Table I, it may be noted that three classes of freshmen who enrolled as ninth grade students in the years 1948, 1949, and 1953 provided a sampling of one hundred sixty-six students. The students in this group had their entire schooling in the public schools of Brookings. Those transferring into the Brookings school system from other schools, other localities, and parochial schools were discarded.

The rural group of students attended various rural schools in Brookings County during eight years prior to enrolling in Brookings high school. Table I shows that there was a total of seventy-seven rural students who enrolled in Brookings high school in the years 1948, 1949, and 1953. During these three years the California Test of Mental Maturity was administered to test mental ability.

TABLE I

NUMBER OF SUBJECTS USED IN THE STUDY
AND THE TEST ADMINISTERED

Class	Freshmen who have been tested		INTELLIGENCE TESTS		
	Rural	Urban	California Test of Mental Maturity	Terman-McNemar	P.M.A.
1948	26	51	X		
1949	28	53	X		
1950	35	56			X
1951	28	64		X	
1952	34	52			X
1953	22	62	X		

NOTE: Brookings high school administers intelligence tests each year. This study uses only the test results of The California Test of Mental Maturity which has been given to the classes of 1948, 1949, and 1953.

Gathering of Data

To make a comparison of rural students with city students as to their natural science background, it was necessary to have test scores for both rural and city groups which indicate the amount of background the student had in science, and test results indicating the mental ability of each student.

The data used in this problem has been taken from the recorded results of previous tests, the Iowa Tests of Educational Development and the California Test of Mental Maturity.

Test results were obtained from the files in the principal's office where a cumulative record folder is kept up to date on each individual. Typical data contained in each folder are such items as: (1) student's name, (2) date and place of birth, (3) family background, (4) hobbies, (5) personal interests, (6) community interests, (7)health, (8) offices held, (9) extra-curricular activities, (10) previous school marks, (11) results from previous testing programs.

The Iowa Tests of Educational Development are administered to all students in grades nine through twelve during the first two weeks of school in September.

Within about three weeks after the administration of the tests in Brookings high school, individual profile cards, showing the results of each student's performance on each of the nine tests in the battery, are returned to the principal.

A sample profile card is included in Figure 1 so that the reader may have a clearer notion of its physical make-up.

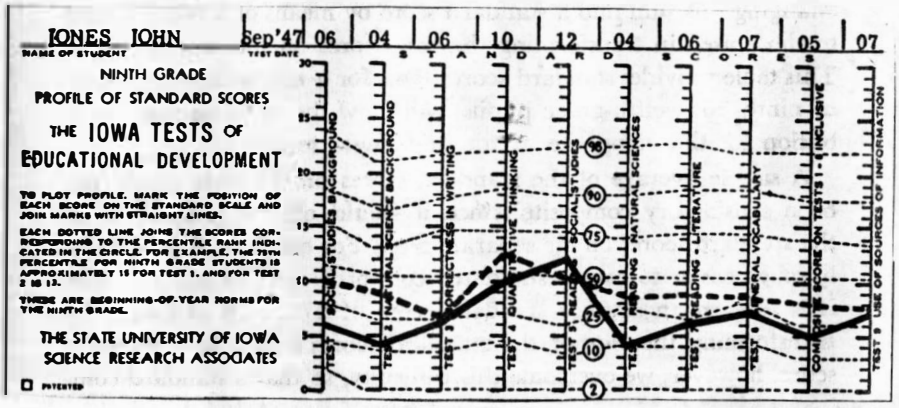


Figure 1. Sample of profile card of the individual student. A similar card is supplied for each pupil who takes the test.

Across the top of each card is the name of the student, date of testing, the standard score on each of the tests, and a composite standard score on Tests one through eight.

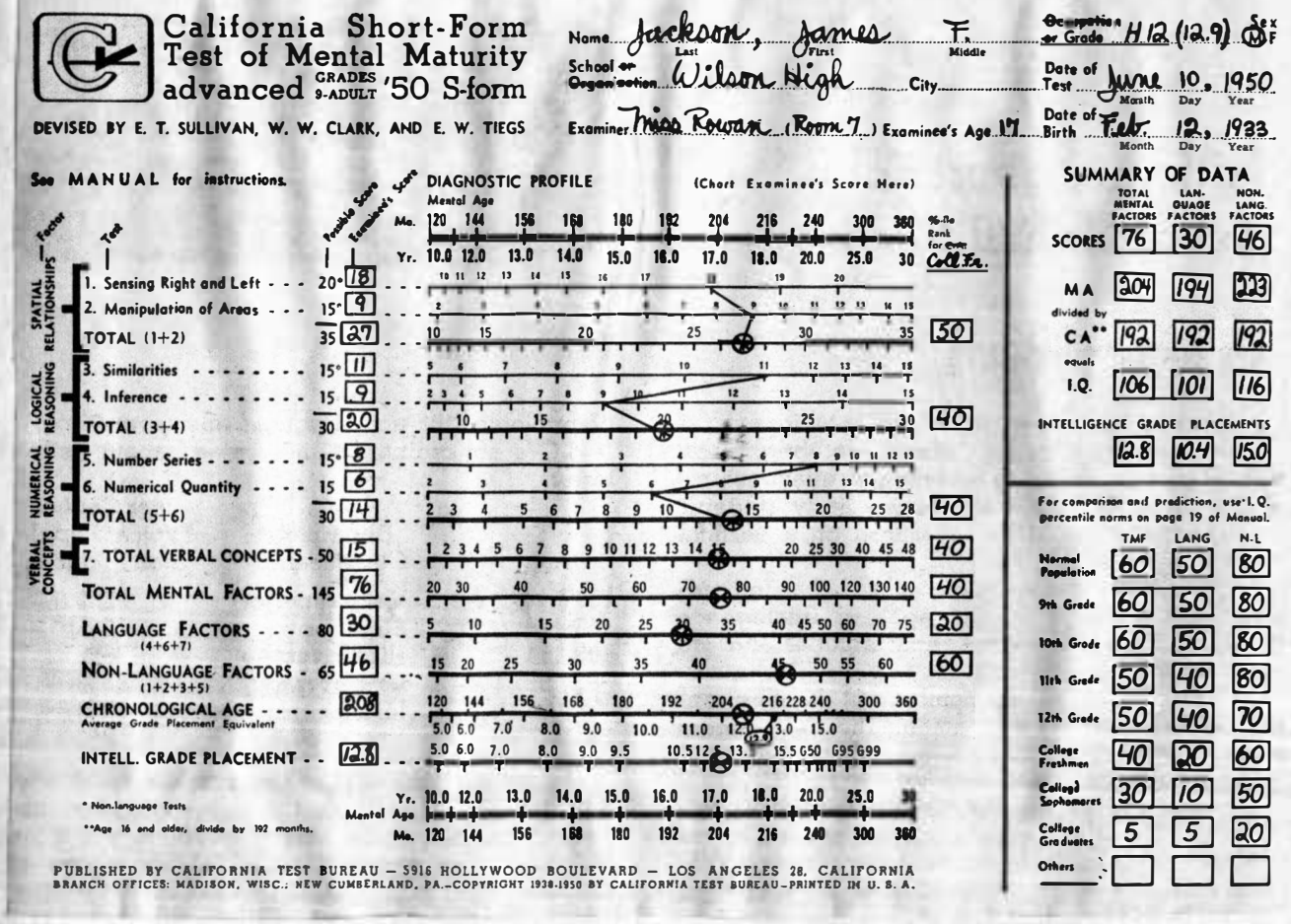
The vertical scales on the card are the standard scales for the nine tests and for the composite.

The irregular dotted lines locate certain selected percentiles in the distribution of standard scores for the grade indicated on the card. The card illustrated in Figure 1 is for ninth grade pupils so that the top dotted line, for example, locates the 98th percentile for the ninth grade pupils on each scale. Cards for other grades have the same standard scale but, of course, not the same percentiles.

By examining each individual's profile card, it was possible for the investigator to obtain a standard score on Test Two, Natural Science Background, for each of the one hundred and sixty-six city students and the seventy-seven rural students.

The scores indicating the mental ability or intelligence quotient (I.Q.) of each student used in the study were obtained by consulting the diagnostic profile sheets of the California Short-Form Test of Mental Maturity. The total mental factors intelligence quotient was used in this study. The language factors intelligence quotient and the non-language factors intelligence quotient were disregarded.

A sample diagnostic profile, Figure 2, has been inserted so the reader may have a better conception as to its physical make-up.



California Short-Form Test of Mental Maturity advanced GRADES 9-ADULT '50 S-form

DEVISED BY E. T. SULLIVAN, W. W. CLARK, AND E. W. TIEGS

Name Jackson, James F. (Last, First, Middle) Occupation or Grade H 12 (12.9) Sex M F

School or Organization Wilson High City

Date of Test June 10, 1950 (Month, Day, Year)

Examiner Miss Rowan (Room 7) Examinee's Age 17 Date of Birth Feb. 12, 1933 (Month, Day, Year)

See MANUAL for instructions.

DIAGNOSTIC PROFILE (Chart Examinee's Score Here)

Factor	Test	Possible Score	Examinee's Score
SPATIAL RELATIONSHIPS	1. Sensing Right and Left	20*	18
	2. Manipulation of Areas	15*	9
	TOTAL (1+2)	35	27
LOGICAL REASONING	3. Similarities	15*	11
	4. Inference	15	9
	TOTAL (3+4)	30	20
NUMERICAL REASONING	5. Number Series	15*	8
	6. Numerical Quantity	15	6
	TOTAL (5+6)	30	14
VERBAL CONCEPTS	7. TOTAL VERBAL CONCEPTS	50	15
	TOTAL MENTAL FACTORS	145	76
	LANGUAGE FACTORS (4+6+7)	80	30
	NON-LANGUAGE FACTORS (1+2+3+5)	65	46
	CHRONOLOGICAL AGE Average Grade Placement Equivalent		208
	INTELL. GRADE PLACEMENT		12.8

Mental Age Mo. 120 144 156 168 180 192 204 216 240 300 360 — Yr. 10.0 12.0 13.0 14.0 15.0 16.0 17.0 18.0 20.0 25.0 30

% -ile Rank for over Col. Fr.: 50 | 40 | 40 | 40 | 20 | 60

* Non-language Tests

**Age 16 and older, divide by 192 months.

SUMMARY OF DATA

	TOTAL MENTAL FACTORS	LANGUAGE FACTORS	NON-LANG. FACTORS
SCORES	76	30	46
MA	204	194	223
divided by CA**	192	192	192
equals I.Q.	106	101	116
INTELLIGENCE GRADE PLACEMENTS	12.8	10.4	15.0

For comparison and prediction, use I.Q. percentile norms on page 19 of Manual.

	TMF	LANG	N-L
Normal Population	60	50	80
9th Grade	60	50	80
10th Grade	60	50	80
11th Grade	50	40	80
12th Grade	50	40	70
College Freshmen	40	20	60
College Sophomores	30	10	50
College Graduates	5	5	20
Others			

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Figure 2. Sample of diagnostic profile of the individual student. A similar profile is supplied for each pupil who takes the test.

Pairing the Groups

Pairing of the two groups was accomplished by two steps: (1) tabulating individual standard scores on Test 2, Natural Science Background, of the Iowa Tests of Educational Development, as shown in Table II, (2) matching the standard scores of rural students with the standard scores of city students, keeping intelligence quotients constant, as shown in Table III.

In tabulating the individual standard scores obtained by city and rural students, on the test in Natural Science Background (Table II), the scores were recorded in the appropriate column which corresponded to the individual's intelligence quotient. The investigator wishes to call attention to the fact that in some cases there were more standard scores to be recorded in the city group than in the rural group. This condition existed because of the unequal numbers of samplings. If the original table were exhibited, it would be noted that standard scores for one hundred and sixty-six city students and seventy-seven rural students would be recorded in accordance with their intelligence quotients.

TABLE II

TABULATION OF THE INDIVIDUAL STANDARD SCORES ON NATURAL SCIENCE BACKGROUND OF THE IOWA TESTS OF EDUCATIONAL DEVELOPMENT

I.Q.	Individual Standard Scores on Natural Science Background on The Iowa Tests of Educational Development	
	CITY	RURAL
127	18	22
123	21 19 19	4
122	21 24	16 16
120	11 18 20 8 17 18	18 24
118	22 19 20 17 14 22	6
117	19 16 7 13 25	16 13
116	9 14 10 23 18 15	21 16 22

NOTE: This table is a sample of the original table used in the investigation and should read as follows:

A city student with an I.Q. of 127 has a standard score in Natural Science Background of 18, while a rural student with an I.Q. of 127 has a score in Natural Science Background of 22. Continuing, three city students, all of whom have an I.Q. of 123, have standard scores in Natural Science Background of 21, 19 and 19, while one rural student with an I.Q. of 123 has a standard score in Natural Science Background of 4.

In Table III, it may be noted that seventy-five city students were matched with seventy-five rural students. Each of the seventy-five matched pairs is made up of one rural student and one city student having identical intelligence quotients. The specific intelligence quotient of each pair is not shown on the Table. Each student's standard score on Test 2, Natural Science Background of the Iowa Tests of Educational Development, has been recorded in the appropriate column for the city and rural groups.

The seventy-five matched pairs making up Table III were obtained from the data found in Table II. By referring to Table II, it will be noted that there are only two individuals with an intelligence quotient of 127. These two students were considered to be a pair and their standard scores of eighteen and twenty-two, which were obtained on Test 2, Natural Science Background, were recorded in Table III, pair 1. By again referring to Table II, it will be noted that there are three city students and one rural student who had an intelligence quotient of 123. The three city students had scores of twenty-one, nineteen and nineteen, on Test 2, Natural Science Background, while the rural student scored four on the same test. In the case of having more samples of city students than rural students, one sample of the three city students was chosen at random to

TABLE III

STANDARD SCORES ON NATURAL SCIENCE BACKGROUND OF MATCHED INDIVIDUALS HAVING EQUAL INTELLIGENCE

PAIR	GROUP URBAN U	GROUP RURAL R	DIFFERENCE BETWEEN PAIRS D	D^2
1	18	22	-4	16
2	19	4	15	225
3	21	16	5	25
4	24	16	8	64
5	17	18	-1	1
6	18	24	-6	36
7	17	6	11	121
8	16	16	0	0
9	13	13	0	0
10	15	21	-6	36
11	14	16	-2	4
12	18	22	-4	16
13	16	14	2	4
14	16	13	3	9
15	16	12	4	16
16	15	7	8	64
17	13	13	0	0
18	20	13	7	49
19	21	15	6	36
20	14	10	4	16
21	15	9	6	36
22	16	12	4	16
23	19	18	1	1
24	13	15	-2	4
25	15	7	8	64
26	16	7	9	81
27	16	11	5	25
28	14	1	13	169
29	18	15	3	9
30	12	12	0	0
31	14	15	-1	1
32	14	9	5	25
33	18	17	1	1
34	12	11	1	1
35	11	1	10	100
36	16	7	9	81
37	7	4	3	9
38	19	5	14	196
39	21	14	7	49
40	16	8	8	64
41	17	18	-1	1
42	17	11	6	36
43	13	7	6	36
44	13	7	6	36
45	10	8	2	4
46	14	9	5	25
47	9	18	-9	81
48	16	15	1	1
49	9	12	-3	9
50	16	6	10	100
51	13	8	5	25
52	18	8	10	100
53	18	20	-2	4
54	12	7	5	25
55	15	12	3	9
56	15	9	6	36
57	5	3	2	4
58	9	20	-11	121
59	16	17	-1	1
60	13	13	0	0
61	12	6	6	36
62	12	11	1	1
63	11	1	10	100
64	13	18	-5	25
65	10	5	5	25
66	14	8	6	36
67	10	16	-6	36
68	5	7	-2	4
69	12	4	8	64
70	7	7	0	0
71	8	5	3	9
72	10	7	3	9
73	15	7	8	64
74	10	1	9	81
75	4	2	2	4
N = 75	U = 1064	Σ R = 822	Σ D = 242	ΣD^2 = 2818

$$M_u = \frac{\Sigma U}{N} = \frac{1064}{75} = 14.19$$

$$M_r = \frac{\Sigma R}{N} = \frac{822}{75} = 10.96$$

$$M_d = \frac{\Sigma D}{N} = \frac{242}{75} = 3.226$$

$$\Sigma d^2 = \Sigma D^2 - \frac{(\Sigma D)^2}{N} = 2037.15$$

$$S.D. = \sqrt{\frac{\Sigma D^2}{N}} = 5.25$$

$$S_{\bar{x}_u - \bar{x}_r} = \frac{S.D.}{\sqrt{75}} = .61$$

$$t = \frac{\bar{M}_u - \bar{M}_r}{S_{\bar{x}_u - \bar{x}_r}} = 5.295$$

be paired with the one rural student. In Table III, it will be noted that the second pair is made up of one city student who scored nineteen on Test 2, Natural Science Background, and one rural student who scored four on the same test. Each of the seventy-five matched pairs tabulated in Table III have been derived by the method described above.

Comparing the Test Scores

To compare the scientific backgrounds of rural educated and city educated students, the investigator refers the reader to the tabulated test results and the accompanying formulas found in Table III.

The reader will note that the mean (M_u) of the standard scores, obtained by the seventy-five city students on Test 2, Natural Science Background, is 14.19. The mean (M_r) of the standard scores on Test 2, Natural Science Background, of the seventy-five rural students is 10.96. The difference between these means or the mean difference (M_d) is 3.226. Whether or not this mean difference is significant remains to be determined by testing the "null hypothesis", using the "t" test of significance.

Treatment of the Data

To evaluate the difference between the means of the two groups statistically, the null hypothesis is assumed. The term "null hypothesis", means that the investigator

assumes that the difference between the means (M_d) is zero. That is, any observed difference in group means is due to chance or sampling fluctuations. This, in many respects, is the most logical hypothesis to test, since the major point the investigator wished to determine is whether an observered difference between the means of the rural and city groups is a real difference.

Fischer's "t" test was used in this investigation as it was recommended for "....the comparison of the performance of different groups under similar situations."[2] This "t" technique is commonly used in educational research in comparable studies.

The formulas used in the computation of the "t" value used in this study followed Edwards' formulas for the "t' test of differences between means for paired or equated groups.[3] The reader is advised to refer to Table III. This "t" value may be evaluated by entering Table IV with the appropriate number of degrees of freedom. The concept of degrees of freedom, symbolized by (df), refers to the number of pairs that are free to vary independently. In

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2 Helen M. Walker, Elementary Statistical Methods (New York: Henry Holt and Company, 1949), p. 286.

3 Allen L. Edwards, Statistical Methods for the Behavioral Sciences (New York: Rinehart and Company, Inc., 1954), p. 278-281.

the present experiment, the number of degrees of freedom is equal to N - 1, where N is the number of pairs of observations.[4] According to Table IV, if the null hypothesis is true, then for seventy-four degrees of freedom, the investigator would expect to obtain a "t" of 1.994 or larger only five per cent of the time, and a "t" of 2.648 will be obtained only once in one hundred times.

When a difference in means is significant at the five or one per cent level of confidence, there is one chance in twenty at the five per cent level, that the differences between the means (M_d) of rural and city students could have been caused by the operation of sampling error alone. If the computed "t" value is less than the tabular "t" value for the five or one per cent level, the difference is not considered significant. If the calculated "t" value equals or exceeds the tabular value of "t" at the five per cent level, the difference between the means (M_d) is considered to be <u>significant.</u> If it exceeds the tabular value of "t" at the one per cent level, the difference between means (M_d) is considered to be <u>very significant.</u>

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4 Allen L. Edwards, <u>Statistical Analysis for Students in Psychology and Education</u> (New York: Rinehart & Company, Inc., 1954) p. 167.

TABLE IV

VALUES OF "t" AT THE 5% AND 1% LEVELS OF SIGNIFICANCE*

Degrees of Freedom	5%	1%	Degrees of Freedom	5%	1%
1	12.706	63.657	32	2.037	2.739
2	4.303	9.925	34	2.032	2.728
3	3.182	5.841	36	2.027	2.718
4	2.776	4.604	38	2.025	2.711
5	2.571	4.032	40	2.021	2.704
6	2.447	3.707	42	2.017	2.696
7	2.365	3.499	44	2.015	2.691
8	2.306	3.355	46	2.012	2.685
9	2.262	3.250	48	2.010	2.681
10	2.228	3.169	50	2.008	2.678
11	2.201	3.106	55	2.005	2.668
12	2.179	3.055	60	2.000	2.660
13	2.160	3.012	65	1.998	2.653
14	2.145	2.977	70	1.994	2.648
15	2.131	2.947	80	1.990	2.638
16	2.120	2.921	90	1.987	2.632
17	2.110	2.898	100	1.984	2.626
18	2.101	2.878	125	1.979	2.616
19	2.093	2.861	150	1.976	2.609
20	2.086	2.845	200	1.972	2.601
21	2.080	2.831	300	1.968	2.592
22	2.074	2.819	400	1.966	2.588
23	2.069	2.807	500	1.965	2.586
24	2.064	2.797	1000	1.962	2.581
25	2.060	2.787	∞	1.960	2.576
26	2.056	2.779			
27	2.052	2.771			
28	2.048	2.763			
29	2.045	2.756			
30	2.042	2.750			

*Table IV has been taken from Table C of Edwards' Statistical Analysis for Students in Psychology and Education Rinehart and Company, Inc., New York, 1946, p. 330.

SECTION III

FINDINGS

According to Table IV, the null hypothesis may be rejected at the one per cent level if "t" is 2.648 or larger. In the present experiment, a "t" of 5.295 was obtained which is greater than the tabular value of "t" at the one per cent level. Therefore, the null hypothesis is rejected at the one per cent level. When the level of confidence is .01 or one per cent, this means that the (M_d) difference between the means of the standard scores in natural science background of rural and city students could only have occurred less than once in one hundred times by chance alone. That is, if similar experiments were performed one hundred times, only one of the experiments would have a difference in means this large.

When the null hypothesis is rejected at the one per cent level, it can be inferred that the difference between the means of the standard scores in natural science background of rural and city children is a significant difference. It is not a difference which can be attributed to chance or sampling fluctuations. In this study there was a real difference between the rural and city students in natural science background which cannot be explained by chance.

SECTION IV

CONCLUSIONS

With the rejection of the null hypothesis at the one per cent level, it is apparent that Brookings city students have obtained a better background in science during their first eight years of education than students who have attended Brookings County rural schools for eight years.

Since the rural and city students were matched according to I.Q., and their standard scores in science compared, the difference between the means (M_d) can not be attributed to a difference in intelligence.

SECTION V

RECOMMENDATIONS

The investigator recommends that more studies should be made by other city schools to determine if there is a significant difference in natural science background between their students and the students who have attended rural schools. It might, further, be advantageous to include other areas, such as spelling, English, reading, social studies, reading experience, and arithmetic skills.

While the researcher cannot make any recommendations on the basis of this study which are conclusive, it would appear that the following suggestions would be worthy of consideration:

(1) Of the eighty-eight certified teachers in Brookings County, eighty-four are teaching with a First Grade or State Certificate and only four have a Bachelor's degree or High School General Certificate. The majority of the eighty-four teachers have a First Grade Certificate. Certification requirements should be restudied with the thought of requiring more preparation for rural teachers

(2) Colleges training teachers should consider setting up work shops and short courses in science to prepare teachers adequately for teaching science.

(3) Boards of Education should consider administrative devices to lighten a teacher's load so that rural school teachers can do a more thorough job of teaching.

(4) Rural school districts should make a special effort to evaluate their facilities and equipment in the light of what is necessary for the teaching of science and make changes accordingly.

(5) Rural schools should consider a change in the date at which the Coordinated Scales of Attainment Test (Forms A and B) are administered. Instead of giving the test at the end of the year, it is suggested that the test be administered at the beginning of the year in order that teachers may make better use of the results as an indication of the strength and weakness of students in various subject areas.

(6) Teachers in rural and city schools should not take for granted the amount of educational background and the mental ability each child possesses but should find out exactly their strength or weakness by comprehensive testing.

(7) Rural school districts should seriously consider reorganization in order that a change may be made from single teacher schools to multiple teacher schools.

(8) Since science is taught in city schools in special classes by specialized teachers, andwhere there are more

adequate facilities and equipment, rural school districts should consider sending seventh and eighth grade students to city schools.

(9) Where practical, it may be desirable to section students in science on the basis of previous tests on natural science background

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